

# NOTES 14: P-VALUES AND SIGNIFICANCE

Stat 120 | Fall 2025

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Last time, we laid out the following steps for setting up a hypothesis test:

1. Formulate hypotheses in terms of *population parameter*
2. Collect data and compute a *sample statistic*
3. Use the *sample statistic* to make a claim about the *hypotheses*

Today, we're diving into step 3:

3a. Construct *null/randomization distribution*

3b. Compute *p-value*

3c. Make a decision about  $H_0$

**StatKey Example 1** In a random sample of 765 adults in the United States, 322 say they could not cover a \$400 unexpected expense without borrowing money or going into debt. A journalist claims that this is evidence that the overall proportion could be 50%. Is the journalist justified?

### **i** Constructing null distribution for a single proportion

In this example, flip a coin 765 times and record the proportion that came up heads. Do this many times to construct the randomization distribution

**StatKey Example 2** In a pre-Musk Pew Research Poll on social media use, 72% of Twitter users ( $n = 346$ ) responded that they visited Twitter a few times a week or more. Among Instagram users ( $n = 530$ ), this number was 80%. Is there a difference in frequency of use between Twitter and Instagram users?

### **i** Constructing null distribution for a difference in proportions

Combine all cases, then randomly assign each case to one of two groups with the same sample sizes as the original data. Record the difference in proportions between the two groups. Do this many times.

### **R Example 1**

Here is what the dataset from the last example might look like in R:

```
# A tibble: 876 x 2
  app      few_times_or_more
  <chr>      <dbl>
1 instagram      1
2 instagram      1
3 instagram      1
4 instagram      1
5 twitter        1
6 instagram      1
7 twitter        0
8 twitter        1
9 instagram      0
10 twitter        1
```

```
# i 866 more rows
```

```
library(CarletonStats)
permTest(few_times_or_more ~ app, data = social_media)
```

```
** Permutation test **
```

```
Permutation test with alternative: two.sided
```

```
Observed statistic
```

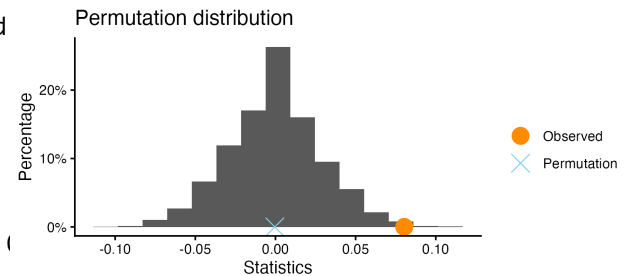
```
instagram : 0.8    twitter : 0.7197
```

```
Observed difference: 0.08035
```

```
Mean of permutation distribution: -0.00039
```

```
Standard error of permutation distribution: 0.0100
```

```
P-value: 0.0064
```



```
*-----*
```

**R Example 2** In a study about Universal Basic Income, the (SEED) randomly selected 100 residents and gave them an unrestricted \$500 a month for 24 months. At the end of the study period, they were given an emotional well-being assessment and results were compared to 100 control-group residents who did not receive payments. The average well-being score among the UBI group was 31.5 and among the control group was 29.5

```
# A tibble: 2 x 3
```

	group	mean	n
	<chr>	<dbl>	<int>
1	Control	29.5	100
2	UBI	31.5	100

```
permTest(well_being ~ group, data = ubi)
```

```
** Permutation test **
```

```
Permutation test with alternative: two.sided
```

```
Observed statistic
```

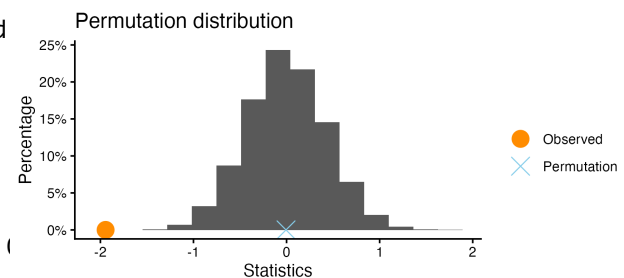
```
Control : 29.54    UBI : 31.49
```

```
Observed difference: -1.944
```

```
Mean of permutation distribution: -0.00576
```

```
Standard error of permutation distribution: 0.0100
```

```
P-value: 1e-04
```



```
*-----*
```

### Constructing null distribution for a difference means

Combine all cases, then randomly assign each case to one of two groups with the same sample sizes as the original data. Record the difference in means between the two groups. Do this many times.

## Statistical Significance

### Note

Significance Level

### Note

Statistical Significance

### Note

Formal Statistical Decisions

## Summary

Whenever performing a hypothesis test, you should:

- (1) Perform an appropriate EDA
- (2) Formulate  $H_0$  and  $H_A$
- (3) Compute a *test statistic*
- (4) Construct a *null distribution*
- (5) Compare the test statistic to the null distribution and compute a *p-value*
- (6) Make a decision (reject or fail to reject) about  $H_0$
- (7) Report your conclusion in context